

mixed in a more crystalline and uniform manner, and others again with a large proportion of their alkaline constituents more or less decomposed, yet there can be no doubt that all the great granitic protuberances from Dartmoor to the Lands End belong to one common geological formation, and are probably of nearly the same geological age.

It may be observed of these masses that the granite of Dartmoor is the most crystalline in its structure, has the finest grain, and is most uniform in its colour. As we proceed westward the granite usually contains more distinct crystals of felspar, which crystals become largest and most varied in colour in the extreme west of Cornwall. This appearance of distinct crystallization in the felspar is supposed to have arisen from an inferior degree of heat in the molten mass of the granite when first protruded, the effect of this inferior heat and consequent fluidity being that the felspar crystallized before the other ingredients, which were afterwards consolidated around the first-formed crystals of felspar. Besides this difference in the original consolidation of the granite, there is another way in which porphyritic granites have been largely produced. It is supposed that the original masses have cracked during the process of cooling, and that the yet fluid igneous matter from beneath has been injected into the cracks or fissures so formed, and has caused those remarkable formations called elvan dykes. These dykes vary in width from a few inches to several hundred feet, and may frequently be traced for many miles in length. It appears that the material injected into the dykes has commonly been at a lower temperature than the adjacent granite, and that although the centre of the dyke may be perfectly crystalline, and not distinguishable from the neighbouring granite, yet the sides of the dyke very frequently exhibit a distinct porphyritic structure, owing, as in the former case, to the crystallization of the felspar before the quartz and mica assumed the solid form.

In some of the granite which is very decomposable, the crystals of felspar are detached from the other ingredients, and can be readily picked out, showing an example of extremely rapid cooling. Specimens of this kind from Lundy Island, may be seen in the Museum of Economic Geology.

The true granite of Cornwall and Devon is always a compound of three or more minerals, adhering together by simple aggregation, and without any cementing substance between them. They all, as far as I have observed, contain the usual triple compound of quartz, felspar, and mica,—the felspar being usually much in excess of the other ingredients, and furnishing generally the most prominent and distinguishing character of the rock, the quartz next in quantity, and the mica last in importance. The felspar is to be readily distinguished by the size and opaqueness of its crystals: the quartz has usually a transparent, lustrous appearance, not exhibiting geometrical figures of crystallization like the felspar; while the mica is usually soft, whitish, and shining, and can be separated into flakes or minute plates with a knife. The relative hardness of the three may be expressed by saying that the mica may be cut by a knife, the felspar can be scratched only, and the quartz will effectually resist all attempts either to cut or scratch it. Besides these ordinary ingredients of granite, this rock in Cornwall and Devon usually contains scapolite, a brownish black and fibrous mineral, which can also be separated into plates like mica, and which occurs chiefly in the outside portions of the granite masses, and is not so common in the central parts. The structure of porphyritic granite has been already explained. It does not differ from that of granite itself, except in having large imbedded crystals, which have cooled before the general mass, and may be described as crystals imbedded in a finer kind of granite. The true porphyries of the West of England are different from this, inasmuch as they have a distinct basis, in which crystals or fragments of other rocks are imbedded. This basis is not the result of crystallization, but of mere mechanical aggregation. Thus we have quartz

porphyry, and felspar porphyry, both named from the imbedded minerals, the former usually consisting of a basis of decomposed felspar, enclosing quartz, and the latter of some other basis enclosing felspar. In many porphyries the basis encloses crystals both of quartz and felspar, the variety and shapes of which give rise to many of its most beautiful forms. Chalcedony and agate also occur in porphyry, and much modify its appearance. The crystals are said to be always of contemporaneous origin with the base, and are not mechanically mixed, like the constituents of sandstone rocks.

The serpentine of the Lizard and other parts of Cornwall is a very beautiful rock, the prevailing colour of which is green, but this is veined by cloudy streaks of black, yellow, and red. The chief constituent parts of serpentine are silica, varying in different places and by different analyses from 32 to 45 per cent.; magnesia, 23 to 37 per cent.; lime, 0 to 11 per cent.; alumina, 0 to 18 per cent.; and volatile matter and carbonic acid, 0 to 14 per cent. It is moderately soft, and can be worked and turned in a lathe. It takes a beautiful polish, and is a highly ornamental stone, being extensively fabricated into vases, columns, pedestals, chimney-pieces, &c. Serpentine ranks as one of the primitive rocks, and in Cornwall is protruded through the granite and older stratified rocks, which it overflows and rests upon.

The granite of De Lank Moor, and that from Hey Tor (see No. 190, Class 1) are favourable specimens of the Devonshire granite, and are especially well known in London. The quarries of Hey Tor are about four miles north of Ashburton, on the eastern border of Dartmoor Forest. They are connected with the Teigngrace canal by a tramroad eight miles in length, formed of granite blocks. The canal passes down to Newton Busel, where it joins the river Teign and communicates with the sea and with the South Devon Railway. The Hey Tor granite was used in the construction of London-bridge, Fishmongers'-hall, Tothill-fields Prison, the pillars of the gates of Christ's Hospital, and for the columns of George the Fourth's library, in the British Museum.

There are also extensive quarries on the western side of Dartmoor, at Foggintor, from which place the stone is brought down to Plymouth by a railway 25 miles in length (see No. 169, class 1). The mode of working this quarry was exceedingly well described a few years ago by Mr. William Johnson, in a paper read before the British Association. He describes the quarry as situate about 350 or 400 feet below the summit of the mountain. The quarry was first opened by means of a gullet, which was driven horizontally until an upright face of rock 50 feet high was reached: this face presented beds of beautiful stone 8 and 10 feet in thickness. The gullet has since been much extended, and the sides cleared away, till the floor of the quarry presented in 1841 a cleared open surface of 4,000 square yards. On both sides, and beyond this cleared space, the quarry is further worked by benches, having an area of about 2,600 square yards, the highest bench being 80 feet above the rails on the floor of the quarry. Blocks weighing 20 tons, containing about 250 cubic feet, have been frequently sent out of this quarry, and it is not uncommon for one shot in blasting to detach and loosen 3,000 tons of stone. The author describes the Foggintor granite as the best in this country for steps, plinths, strings, blocking courses, ashlar, pedestals, obelisks, columns, cornices, and indeed for all other purposes of architecture. It is also very peculiarly fitted for the massive works of hydraulic engineering, as in docks and harbours, on account of the great sizes in which the blocks may be procured. Hence it has been very extensively used for copings and mooring posts, also for the hollow quoins and projecting quoins of dock and lock gates, for the altars or retreating benches of graving docks, as well as for the heaviest and most massive parts of bridges and other engineering works. The works at the Devonport Dockyard, those of the magnificent new graving-dock at Woolwich, Fenby Beacon in Pembrokeshire, the

Neale memorial in the New Forest, Hants, the Nelson column, and the retaining walls in Trafalgar-square, and the new buildings of the Sun and Alliance Fire Office all furnish examples of the Foggintor granite.

Besides the varieties of Devonian granite already mentioned, the Exhibition is rich in specimens of Cornish granite, a few of which I proceed to mention. The district around Truro (No. 164) sends several varieties of granite, besides a great many porphyries from the numerous dykes in the neighbourhood. These have been marked and arranged with much care, and their value pointed out as building stones, materials for road-making, &c. In No. 169 are several specimens of red porphyritic granite and porphyritic elvans from the neighbourhood of Launceston, Chace-wring, and Landrean North. In the district of St. Austell much of the granite is in a very decomposing state, the felspar being frequently converted into *kaolin*; and the St. Austell committee (No. 168) have sent up a specimen of soft granite, which may be described as a very light-coloured stone, with the felspar in an amorphous, uncrystallized state, the quartz very light-coloured and diaphanous, the mica white, and in very small plates. The blue granite from Roche, also sent by the St. Austell committee, deserves notice. The felspar here is very indistinctly crystallized, the quartz very crystalline and translucent. In No. 160 we have several specimens from the neighbourhood of Penryn and other places in the granite district which lies on the west side of Falmouth. In all these specimens the felspar is in more distinct and better defined crystals than in the Dartmoor granite. The Penryn stone, as well as that from the Constantine quarries, on the opposite side of this granite district, stands in high repute amongst engineers and architects, and one or other of them has been used in Waterloo-bridge, at the dockyards of Deptford, Woolwich, Chatham, Portsmouth, steam-basin at Keyham, British Museum, Royal Exchange, Phoenix Fire Office, and many other important buildings. The collection, No. 160, which is very extensive, and is contributed by Messrs. W. and S. Freeman, also comprises specimens from the most remote mass of granite which this country contains; namely, that which occupies the Lands End in the extreme western part of Cornwall. Amongst these are blocks from Moseman Quarry, from Lamorna Quarry, near Penzance, and from Zennor Quarry, St. Ives, the shipping port for all these being Penzance. In these granites, as before observed, the felspar crystals are very large, frequently measuring 6 or 9 inches in length by 2 or 3 inches in breadth. These granites have been employed in her Majesty's dockyards at Deptford, Woolwich, Chatham, and Portsmouth, the steam-basin at Keyham, Dover Pier, and Hull Docks. Messrs. Freeman also exhibit outside the building specimens to show the size of the blocks which may be procured from the Penryn and Penzance granite, namely, an obelisk in one piece from Lamorna quarry, 24 feet 4 inches in height, and weighing 31 tons; also the base of the obelisk from Carnosew, near Penryn, weighing 31 tons. This collection comprises some beautiful varieties of greenstone porphyry, especially one called *polyphant stone*, from Lewannick Quarry, Launceston; Cornwall. This stone takes a highly ornamental polish, and was used in Lewannick Church, Launceston Castle, Alternum Church, &c.

In No. 159 are several specimens of fine grained porphyry, among which is a white variety of great beauty, which would be suitable for building purposes. No. 161 contains some highly ornamental slabs of porphyry with polished faces, the area of each being about 15 square feet. One of these is a specimen from Retine-in-Witfield, Cornwall, with a greyish cream-coloured ground, containing unbedded crystals of white felspar, crystalline quartz, and black scapolite: two other specimens from the same place have a flesh-coloured reddish ground, with white felspar crystals of all sizes, up to 2 inches by 3-4ths of an inch, in some places speckled with black scapolite, all sizes up to the diameter of a six-